

The Development of Human Factor Guidelines for Unmanned Aircraft System Control Stations



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Control Stations



Control Stations

- Inadequate feedback to crew on system state
- Multi-mode controls
- Difficult to read fonts and colors
- Placement of critical controls next to non-critical controls
- Unreachable controls
- Reliance on text displays
- Display proliferation



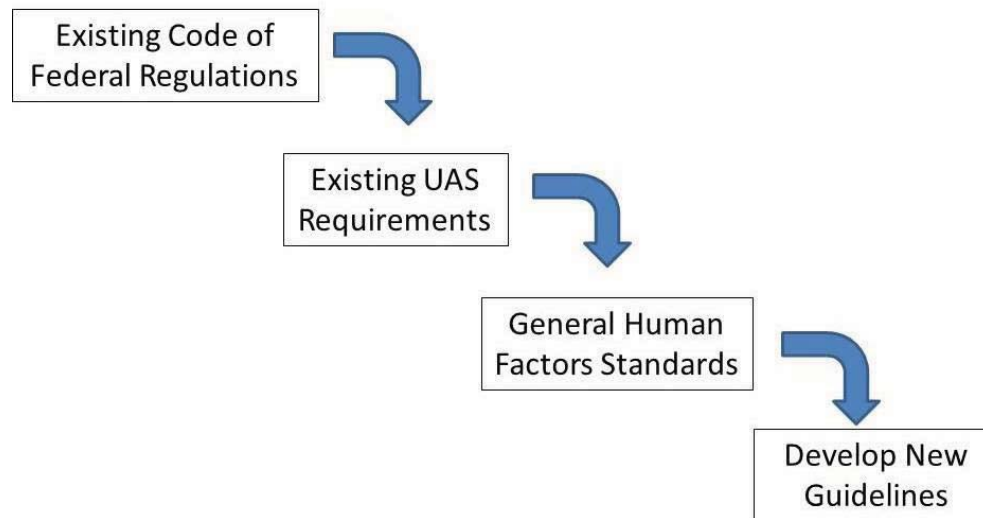


Human Factor Design Guidelines

A statement describing a characteristic of the engineered system with the intention of promoting safe and effective human use.

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Examples of Existing Guidelines

- Unmanned Aircraft Systems
 - Draft NATO UAV Standardization Agreements
 - Draft Access 5 Guidelines
 - Draft CASA Design Standards for UAVs
 - US DoD UAS GCS Human Machine Interface Guide
- Conventional Cockpits
 - FAA & EASA regulations
 - FAA Human Factor Design Guidelines for Multifunction Displays
 - RTCA, SAE, ASTM, GAMA
- General Human Factors
 - MIL STD 1472 Human Engineering
 - ANSI/HFES Human Factors Engineering of Computer Workstations
 - ISO 9241 Ergonomic Requirements for Office Work with Visual Display Terminals
 - ISO 110641 Ergonomic Design of Control Centers

Guidelines for Guidelines

Consistent	As well as being internally consistent, guidelines should not conflict with regulations and other mandatory requirements.
Achievable	Achieving the intent of the guideline should be within current technical capabilities.
Assessable	It should be possible to evaluate whether the intent of a particular guideline has been met.
Evidence-based	Guidelines should address areas of need identified from operational experience, simulations or analysis.
Organized	Guidelines should be organized hierarchically, with general statements preceding specific statements.
Not overly prescriptive	Overly prescriptive statements should be avoided as they may constrain innovation.
Not premature	In the case of immature or evolving technologies, guidelines should be developed with the awareness that prematurely developed guidelines may not reflect the characteristics of the technology once it matures
Applicable to diverse systems	Guidelines should address a wide range of technological solutions and capabilities. Some guidelines will have general applicability, while others will address issues unique to particular technologies.

Possible Topic Areas

- Displays
 - Replacements for lost sensory cues?
 - Signal strength, latency, approach to limit of signal
 - Other radio frequency users?
 - Status of ground station
 - Out-the-window view?
 - Obstruction of displays (by screen savers, pop-up windows)
- Controls
 - Number of mouse click or menu steps
 - Acceptable time to respond
 - Potential for wrong response
- Decision support & planning
 - Awareness of logic of automation
 - System behavior in event of lost link or system failure
 - Weather and traffic avoidance
 - Flight termination decision making
 - Control handover

Principles
Properties of the
engineered system

Principle: A human factors concept that relates to whole-of-system functioning, or that has broad applicability across the engineered system.

Property: Desired physical or functional properties of controls or displays.

Information and control
requirements

Information requirement: Information that must be provided by the engineered system to the human to enable a task to be performed.

Control requirement: Inputs that the engineered system must be capable of receiving from the human.

Tasks

Task: A human activity that supports a system function.

Design-agnostic system performance
requirements

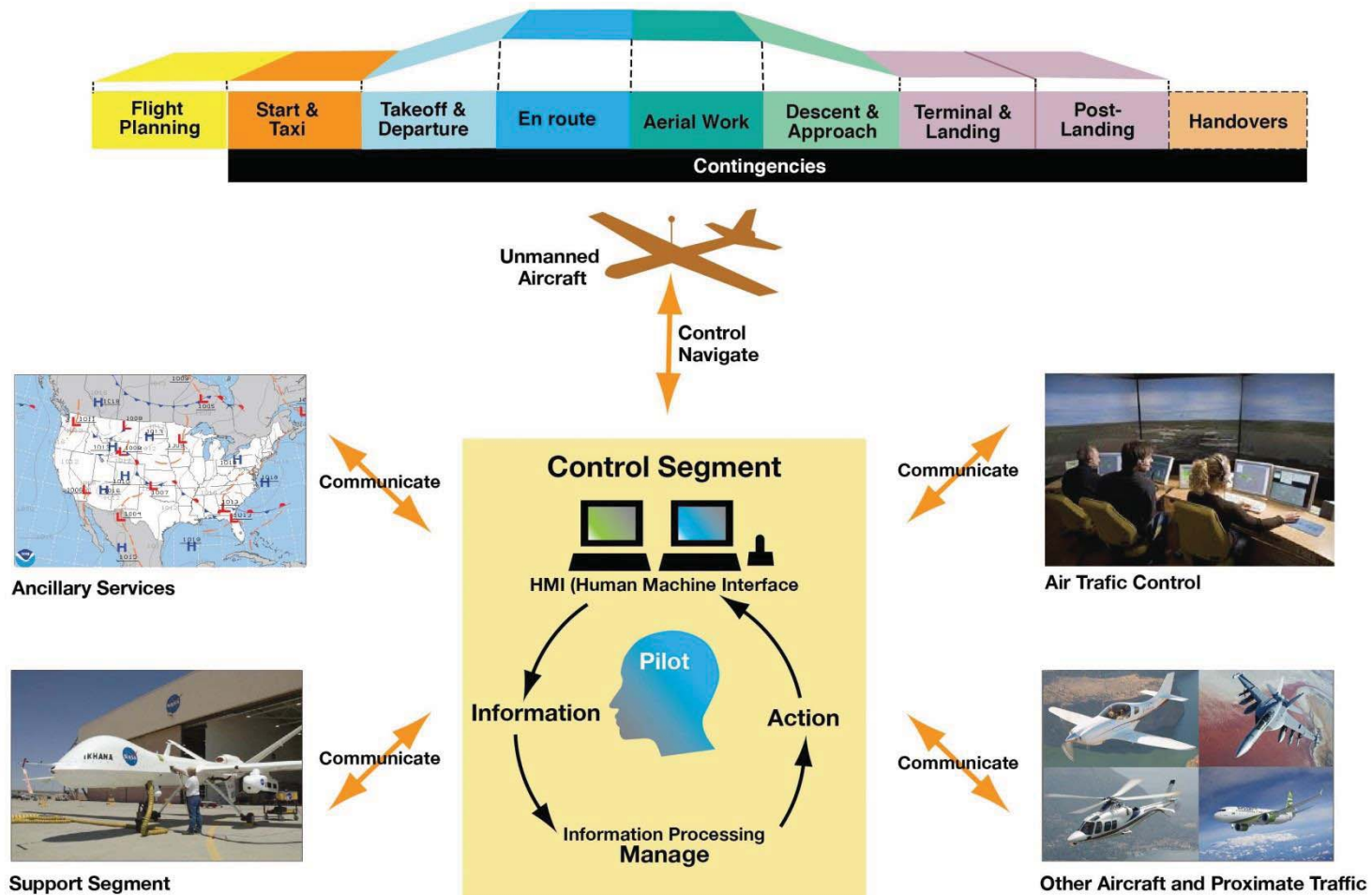
Assumptions

- Each UAS will have a pilot in command
- Pilot can assume control at all times during normal operations
- Operations will not be autonomous during normal operations

Out of Scope

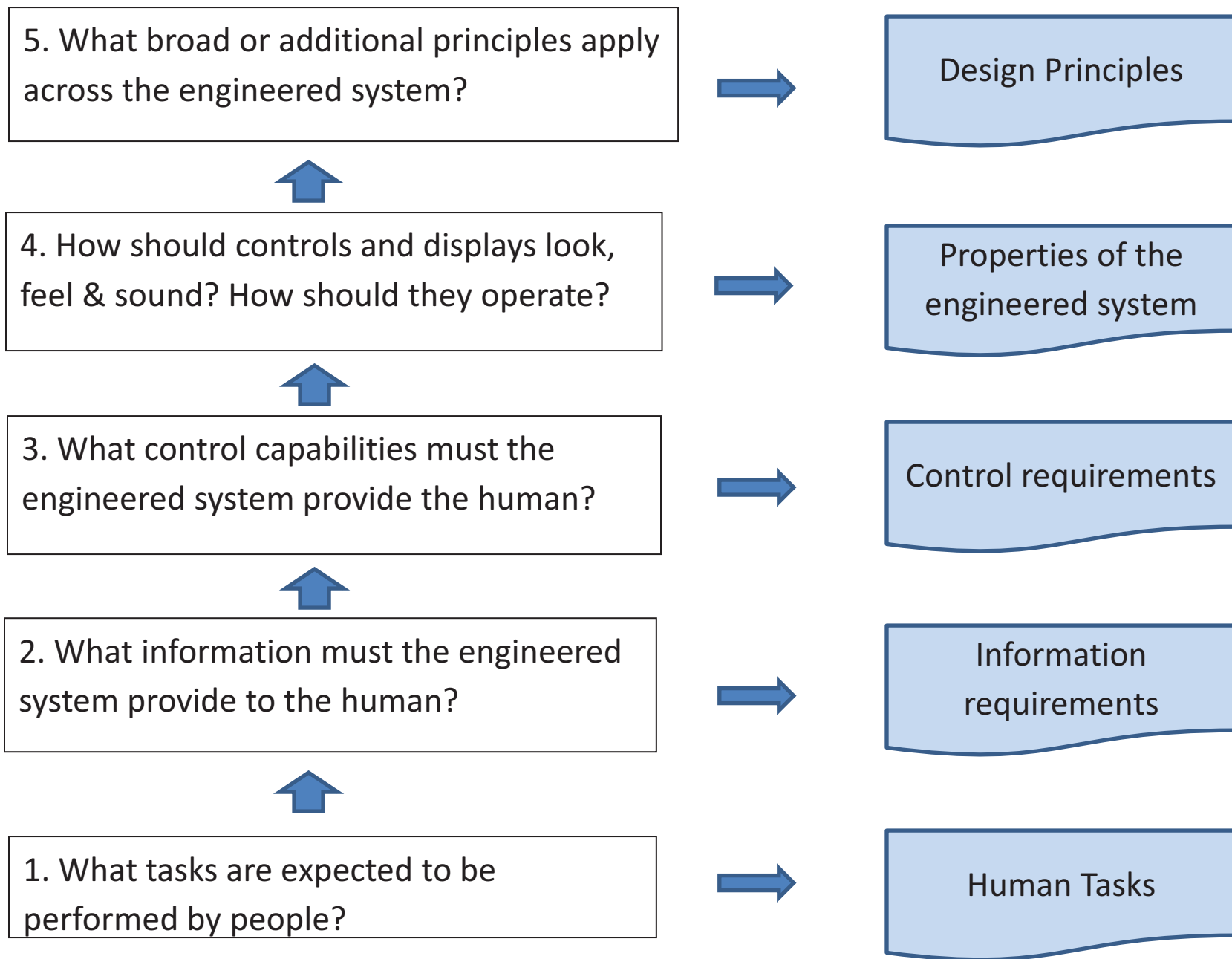
- Control of multiple aircraft
- Line-of-sight operations
- Payload
- Procedures
- Personnel qualifications
- Training
- Security

The Role of the UAS Pilot



Levels of human involvement

Direct human involvement, human supervises automation, human monitors automation



Manage

Plan for normal and non-normal conditions

Make decisions in normal conditions

Recognize and respond to non-normal conditions

Handoff control

Aviate

Monitor and control aircraft systems, including automation

Monitor consumable resources

Monitor and configure control station

Maneuver to avoid imminent hazard (e.g. aircraft or terrain)

Monitor and control status of links

Send aviate commands to aircraft

Navigate

Control and monitor location and flight path of aircraft

Remain clear of static hazards (e.g. terrain, airspace boundaries)

Remain clear of dynamic hazards (e.g. weather, other aircraft)

Send navigation commands to aircraft

Communicate

Communicate with ATC

Communicate with other airspace users

Communicate with other flight crew or ground support

Communicate with ancillary services (e.g. weather)

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Design-agnostic system performance
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- Confirm spectrum availability before selecting link
- Select communication mode (e.g. terrestrial/satellite, frequency)
- Confirm that communication link is effective & established with correct UA
- Maintain awareness of link strength & quality
- Maintain awareness of geographic limits of link & potential obstructions to signal
- Change link in flight
-

Principles

Properties of the
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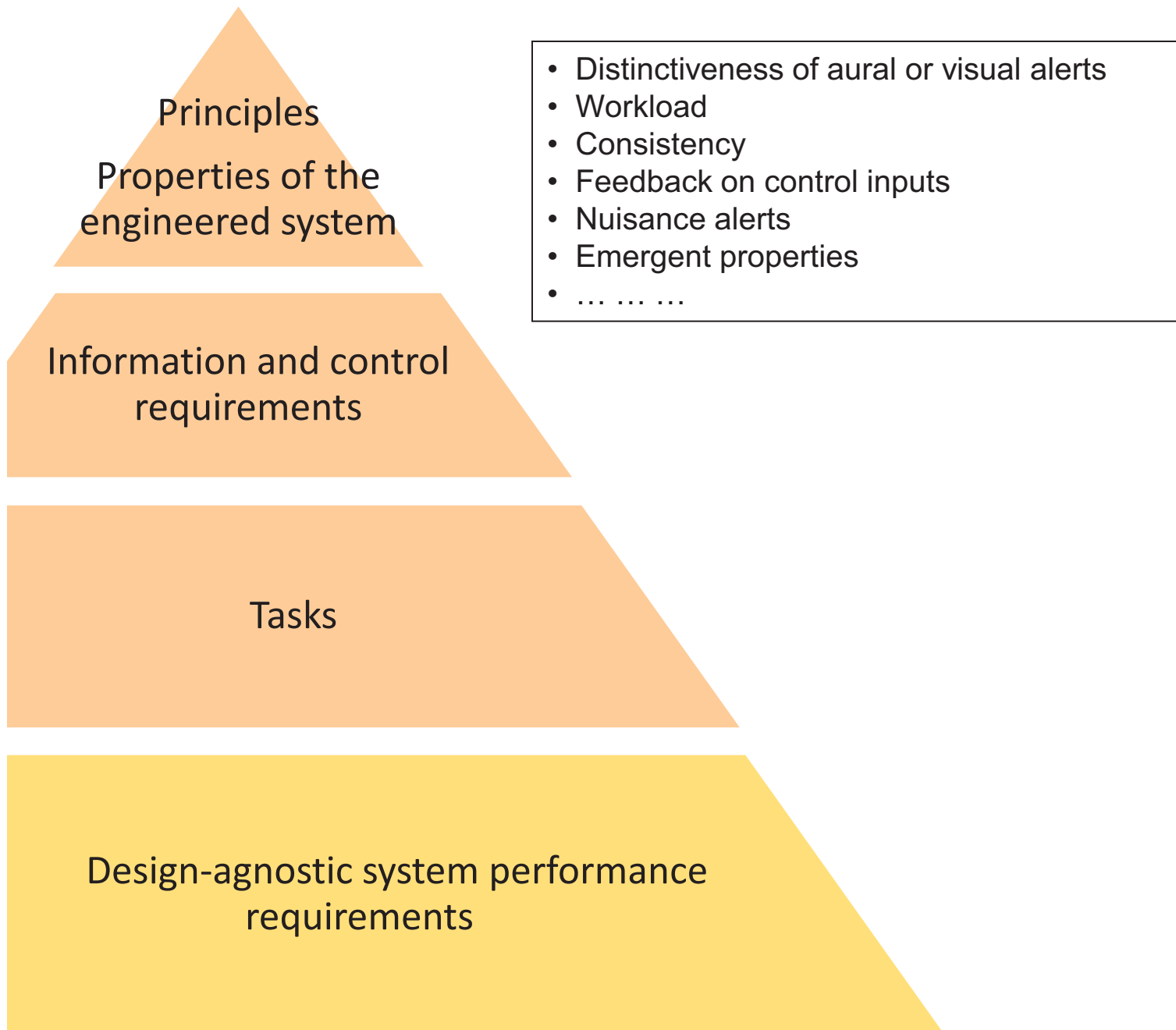
Information and control
requirements

Tasks

Design-agnostic system performance
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The control station will ...

- provide the pilot with information on the quality of the control link before the link is actively used to control the UA.
- provide the pilot with the information necessary to identify which link settings are active (e.g. selected frequency, satellite vs terrestrial)
- alert the pilot when the link is lost or significantly degraded
- provide a means for the pilot to select communication mode (e.g. terrestrial/satellite, frequency)
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Human factors engineering process

HFE processes

- Test and evaluation
- Task analysis
- Human failure modes and effects analysis
- Human factors probabilistic risk assessment
- Operational experience review and lessons learned
- ...
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“Human errors occurring in the performance of critical tasks during test and evaluation should be analyzed to determine the reason for their occurrence”. (Department of Defense, 1999)

Conclusions

- Has been a failure to apply existing standards + lack of UAS-specific guidelines
- We can not wait for operational events to identify where UAS-specific guidelines are needed
- Guidelines will need to be regularly updated as experience accumulates

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